LONG-TERM IN SERVICE EVALUATION OF STRIP PARQUET WITH MODIFIED WOOD FACE LAYERS
Introduction

Tree species distribution of Hungary

100% = 1.903,4 Mio ha
100% = 351.9 Mio m^3

- Black Locust: ca. 450,000 ha
  ca. 50,000,000 m^3

Conifers
Other broadleaves
Indigenous poplar
Improved poplar
Black locust
Hornbeam
Beech
Turkey oak
Oak
Introduction

Gross annual increment

Total: 13.1 million m$^3$

- Black Locust: ~3 million m$^3$
Fellings by tree species

- Black locust: ~1.5 million m³
- Improved poplars: 2.8%
- Indigenous poplar: 16.6%
- Turkey oak: 13.1%
- Conifers: 9.9%
- Hornbeam: 12.5%
- Other soft-broad-leaved: 13.2%
- Other hard broad-leaved: 2.6%
- Beech: 4.3%

Total: 7,024 million m³
Introduction

Area of Robinia forests by Yield Class

- Yield C I: 28.2%
- Yield C II: 0.4%
- Yield C III: 16.5%
- Yield C IV: 21.8%
- Yield C V: 3.7%
- Yield C VI: 29.4%

Total area: ~450,000 ha
### Physical and mechanical properties of robinia

<table>
<thead>
<tr>
<th>Property</th>
<th>Oak</th>
<th>Robinia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (kg/m³)</td>
<td>690</td>
<td>770</td>
</tr>
<tr>
<td>Bending strength (MPa)</td>
<td>110</td>
<td>140</td>
</tr>
<tr>
<td>Surface hardness (MPa)</td>
<td>66</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td>MOE (Mpa)</td>
<td>12000</td>
<td>14000</td>
</tr>
<tr>
<td>Radial shrinkage (%)</td>
<td>5,47</td>
<td>3,2 - 4,6</td>
</tr>
<tr>
<td>Tangential shrinkage (%)</td>
<td>7,87</td>
<td>5,4 - 7,2</td>
</tr>
<tr>
<td>Longitudinal shrinkage (%)</td>
<td>0,39</td>
<td>0,49</td>
</tr>
<tr>
<td>Volumetric shrinkage (%)</td>
<td>13,35</td>
<td>11,4 - 12,2</td>
</tr>
</tbody>
</table>
The overall goal of this study was to investigate the behaviour of Black Locust flooring under service and in laboratory conditions with different cover top layers (untreated as well as light and dark steamed Black Locust, plus oak for comparison).

The specific objectives are the following:

- to investigate the changes in appearance of pre-fab flooring in long term (5 years) indoor service and
- to test selected properties of pre-fabricated flooring in the laboratory.
Materials and methods

• The flooring material was processed and coated in a regular production line of a Hungarian company (Drávaparkett, Barcs).
• Surface treatment: hard natural oil, in order to reduce the influence of coatings on surface wear and to control its influence on abrasion
• The pre-fab flooring material is defined as follows:

<table>
<thead>
<tr>
<th>Surface treatment - Oil:</th>
<th>Materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>primer: transparent oil</td>
<td>O - oak</td>
</tr>
<tr>
<td>(35-40g/m²)</td>
<td></td>
</tr>
<tr>
<td>top: transparent oil,</td>
<td>N - natural Black Locust</td>
</tr>
<tr>
<td>high solid (25-30g/m²),</td>
<td></td>
</tr>
<tr>
<td>Manufactured by</td>
<td>L - light steamed Black L.</td>
</tr>
<tr>
<td>Waterlox Coating</td>
<td>85°C / 48h</td>
</tr>
<tr>
<td>Corporation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D - dark steamed Black L.</td>
</tr>
<tr>
<td></td>
<td>95°C / 48h</td>
</tr>
</tbody>
</table>
Core layer: spruce      |
Bottom layer: spruce    |
Cross sectional structure of the flooring

- Tenon:
  - 208 mm
  - 4 mm
  - 6 mm
  - 4 mm

- Notch:
Physical properties of the pre-fab floorings

(Laboratory Test)

• **Abrasion resistance:**
  Investigation of the abrasion behaviour of the **four different types** of pre-fab floorings.

  **Standard used:** ASTM D4060-95
  **Specimen dimensions:** 100x100mm²
  **Sample size:** 30 units per each flooring type

• Measurements were done by weight loss and by thickness loss (at four points) after 400 rotations both on oil treated and untreated floorings.

• **BM-hardness**
  On the same specimen
Steaming has a noticeable effect on abrasion resistance by oil treated material. Light steamed black locust wood had the lowest thickness loss -- highest resistance.
Steaming does not have significant effect on the BM-hardness. Oiling slightly increased the hardness by natural and dark steamed Black Locust. Oak-layer showed the lowest BM-hardness.
Is the BM-hardness test a reasonable approach for abrasion resistance? – Correlation tests

(Laboratory Test)

From that kind of investigations can be concluded, that however the BM-test are more convenient then the abrasion test, it **gives no reasonable results regarding the abrasion.**
Deformation and dimensional changes

(Laboratory Test)

- Element dimensions: 850 x 208 mm²
- Sample size: 6 units (taps) per each flooring type
- Relative humidity steps:
  - 65% ⇒ 33% ⇒ 84%

- Determination of:
  a/ Form stability in accordance with the German Standard of DIN 52181
  b/ Dimensional stability (shrinking/swelling) in accordance with the Standard of EN 318/193
Performance of each sample was ranked into four classes. The material showing the least deformation/shrinking/BM hardness/abrasion resistance was ranked number 1 and that showing the highest was ranked number 4.

<table>
<thead>
<tr>
<th>Mate-rial</th>
<th>Incr. in width RH%</th>
<th>Incr. in length RH%</th>
<th>Curv. in L. RH%</th>
<th>Curv. in W. RH%</th>
<th>BM-h RH%</th>
<th>Abr. res.</th>
<th>Sum of classification numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>N</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>O</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>24</td>
</tr>
</tbody>
</table>

In the table can be seen, that the flooring elements with **dark steamed** black locust top layer reached the highest scores, thus this material is the **most sensitive** against moisture changing and abrasion.

While elements with **light steamed** BL top layer showed the **highest stability** and abrasion resistance.
Stairs form the Entrance door

Set up plan of pre-fab flooring layout
View of the pre-fab floor in the test area

(Indoor service Test)
Indoor service test

• Visual observations were recorded every three months.
• Intensified abrasion + extreme moisture changes
View of the pre-fab floor in the test area

Initial condition

After 5 years in service
Results of the visual observations

• Duration: 5 years

• 1st year (October) - wet spots along the joints between taps and elements, by rainy weather and after cleaning.

• 2nd year (May) - colour became grey (in dry cond.). Oiling wore down after 6 months.

• 2nd year (May) – 4th year (February) - no other noteworthy changes

• 4th year (May) - top layer became humpbacked on 6 places regardless the wood species and position. Average area: 20-50 cm².
Designation of the measurement layout
/after 5 years in service/

Test area for BM-hardness and abrasion resistance

Without abrasion - control for thickness of the top layer
BM-hardness values after 5 years in service

(Indoor service Test)
By natural BL and by oak nearly the same values.
By steamed BL higher abrasion after indoor service.
Surface character of the flooring after indoor service

(Indoor service Test)

Radial and tangential sections from Black Locust

Differences between radial and tangential sections
- Radial section: rough surface, because of narrow early and late wood zones
- Tangential section: relative smooth and waved surface, because of wide late and early wood sections
Surface character of the flooring after indoor service

(Indoor service Test)

Radial and tangential sections from oak
Influence of large rays by oak

(Indoor service Test)

Tangential section

Smooth surface

Rough surface

Radial section
## Conclusions

### Laboratory tests

- **Abrasion**
  The light steamed and dark steamed BL wood had the **highest** abrasion resistance.

- **BM-hardness**
  Steaming does not have significant effect on the BM-hardness. Oak- layer showed the lowest BM-hardness.

- **Dimensional stability**
  Flooring elements with dark steamed Black locust top layer showed the highest shrinking and curvature. Oakwood was the most stable material.

### Indoor service

- **Abrasion**
  The light steamed and dark steamed Black locust wood had the **lowest** abrasion resistance.

- **BM-hardness**
  Steaming does not have significant effect on the BM-hardness. Oak- layer showed the lowest BM-hardness.

- **Dimensional stability**
  ---
Conclusions

• Anatomical section of the top layer influences not only the appearance but during the service the roughness of the surface too.

• Rays by oak wood are more resistant against abrasion.

• Parquets with steamed Black Locust have comparable properties to parquets with oak top layer and therefore Black locust is safely recommended for substituting of oak.
Thank you for your attention!